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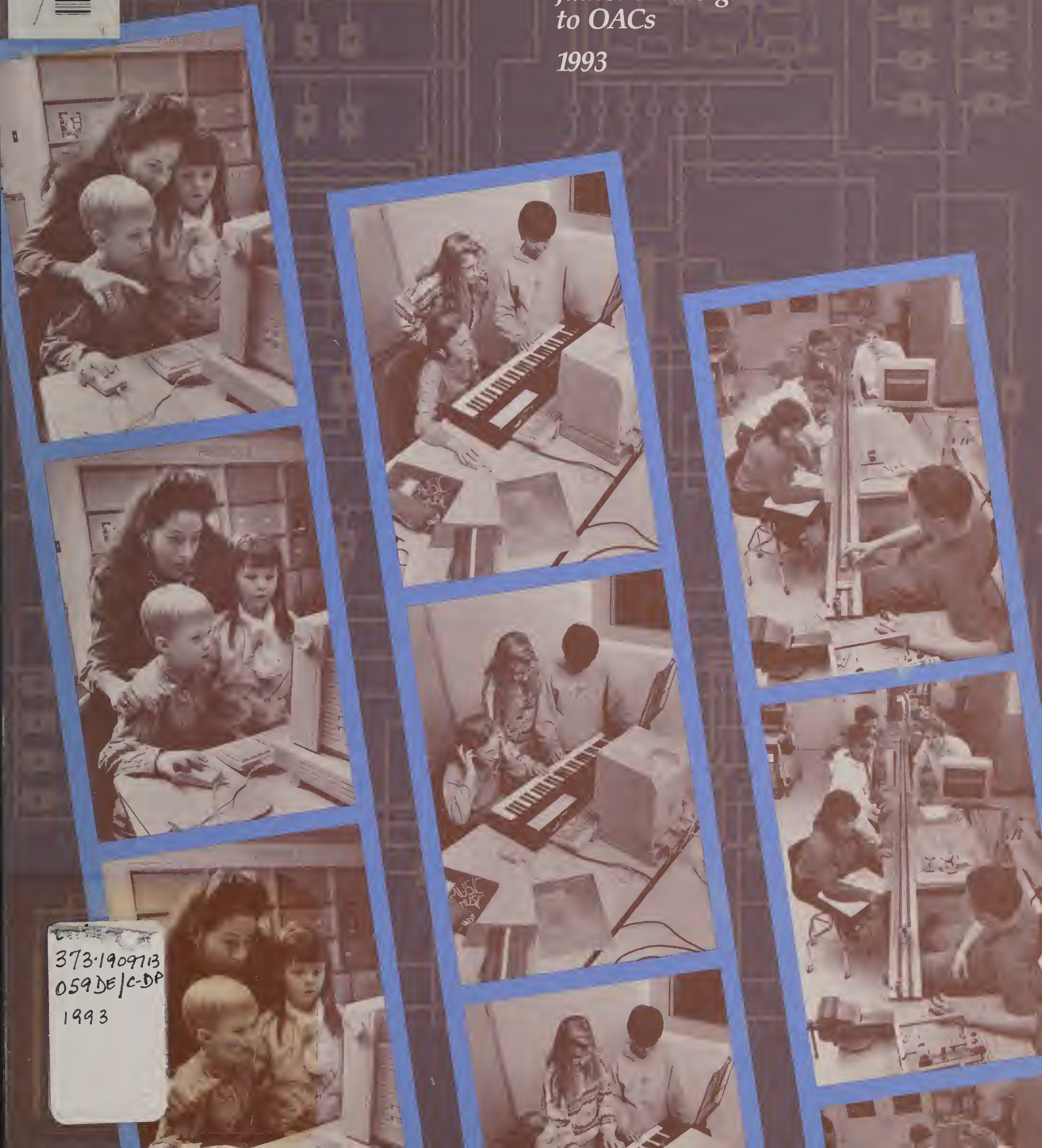
RESOURCE GUIDE

COMPUTERS ACROSS THE CURRICULUM

Junior Kindergarten to OACs

1993



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PREFACE

The educators of Ontario continue to adapt to the constant demands in our ever-changing society and strive to provide the best education possible for the learners of this province. These changes offer an opportunity for growth to both the educator and the learner.

Learners in Ontario require opportunities to acquire and maintain computer skills necessary for living and working in an information society. This document provides direction to Ontario's educators on how to integrate the use of computer technology, on an equitable basis, into all areas of the curriculum.

When formulating plans for the integration of computer technology into the curriculum, school boards[1] should use this document in conjunction with Policy/Program Memorandum No. 116 (see Appendix 1) and with other policy/program memoranda on the use of computers in the classroom. The Ministry of Education and Training will continue to review and revise policy on the use of computers in the classroom, and will issue further policy/program memoranda on this topic, as necessary. Principals and teachers also should be aware of all of these policy statements.

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[1] The term *school board,* as used in this document, includes French- and English-language sections of school boards.

INTEGRATION OF THE USE OF COMPUTER TECHNOLOGY INTO THE CURRICULUM

RATIONALE AND OBJECTIVES

A fundamental goal of the Ontario education system is to prepare learners for living and working in today's and tomorrow's society. Societies are not static; they change and evolve. One change that can be predicted with some certainty is that technology – already very important in our society – will have an increasingly significant impact on people's lives. The rapid pace of innovation in technology makes enormous demands on the individual. Throughout their lives, people learn in order to respond and adapt to the changing needs of the workplace. Their ways of learning and of reacting to the world will be modified as technology alters the environment.

In recent decades, some of the most dramatic changes in the way people live and work have been linked to the development of computers. Computers ushered in "the information society", and computers of all kinds play an increasingly important role in everyday life. For example, the use of database, word-processing, spreadsheet, graphics, and multi-media software packages to facilitate the gathering, storage, processing, enhancement, and communication of information is becoming more and more prevalent.

The education system must enable learners to acquire the knowledge, skills, and attitudes they will need to adapt constructively to societal change. Ontario educators are aware that understanding and using computers is important for learners. Educators are also aware of the valuable role computers can play in enhancing the learning experience. Research[2] into the uses of computers in the classroom has shown that they can provide learners with opportunities to explore, create, solve problems, take risks, and communicate. For example, computers can:

- enable learners to examine the range of options presented in decision making and to make informed choices by allowing them to simulate environments and situations otherwise not available to them;
- allow learners to test a variety of solutions, analyse results quickly, and make predictions on the basis of existing and hypothetical data;
- motivate learners and help them to improve the quality of their work;
- enable learners to increase their productivity;
- provide learners with immediate feedback;
- help learners to apply the knowledge and skills they have acquired to new problems and situations;
- help learners to take responsibility for their own education and become autonomous learners;
- assist and facilitate communication for exceptional students, to enable them to approach learning from their areas of strength;
- address individual learning styles;
- help learners to understand and appreciate the many ways in which computers affect their daily lives.

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[2] Recent research into the use of computers within the classroom includes: A. Clarkson and K. Pegley, *An Assessment of a Technology in Music Programme*, Technical Report 91-2 (Toronto: Centre for the Study of Computers in Education, York University, June 1991); R. D. Owston, S. Murphy, and H. Wideman, *On and Off Computer Writing of Eighth Grade Students Experienced in Word Processing*, Technical Report 90-1 (Toronto: Centre for the Study of Computers in Education, York University, May 1990) and *Effects of Word Processing on Student Writing in a High Computer Access Environment*, Technical Report 90-3 (Toronto: Centre for the Study of Computers in Education, York University, November 1991); and J. D. E. Underwood and G. Underwood, *Computers and Learning: Helping Children Acquire Thinking Skills* (Oxford: Basil Blackwell, 1990).

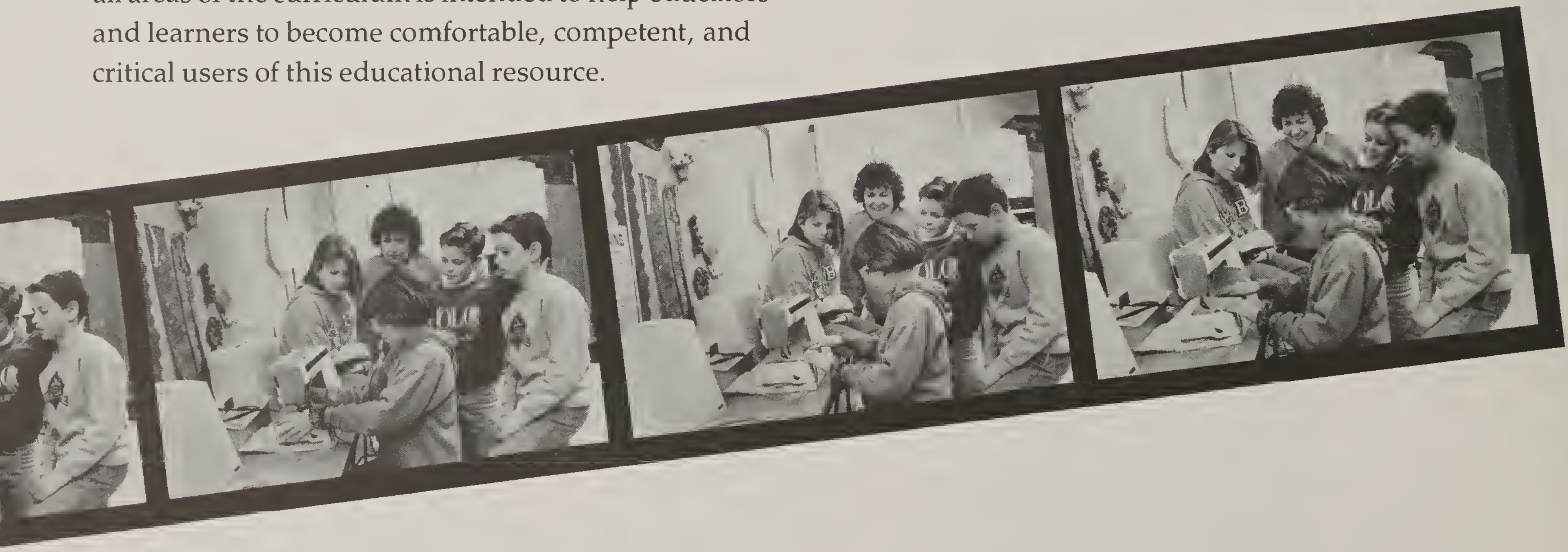
Computers Across the Curriculum is designed to help educators realize the twin objectives of (1) enhancing learning in all areas of the curriculum and (2) enabling learners to acquire and maintain a variety of computer skills. It will be necessary for learners to develop a broad understanding of the present and potential capabilities and uses of computers. Such a broad understanding will ensure that they can adapt more readily to the inevitable transformations in this rapidly changing field. The acquisition of computer skills in this latter sense is more readily achieved through the provision of numerous opportunities for learners to employ the computer as a working and learning tool for a wide variety of tasks and purposes and in many different contexts. It is for this reason, as well as for the obvious benefits of using computers to enhance learning across the curriculum, that it is important to integrate the use of computers into the whole curriculum rather than merely to include it as an isolated subject.

AIMS

In order to help learners acquire the knowledge, skills, and attitudes they will need for lifelong learning, educators need to make use of a number of different learning tools, of which the computer is one. In general, the integration of the use of computers into all areas of the curriculum is intended to help educators and learners to become comfortable, competent, and critical users of this educational resource.

To achieve this outcome, those involved in the review, development, and implementation process should provide ways to:

- make the use of computers in the educational setting as inviting as possible;
- incorporate the use of computers into all areas of the curriculum from Junior Kindergarten to Ontario Academic Courses;
- involve learners on an equitable basis in computer activities;
- encourage learners to regard the use of computers as they do the use of other educational tools – that is, as an "everyday" part of the learning process and the learning environment;
- enable learners to use computers for a variety of educational purposes (e.g., experimentation, inquiry learning, problem solving, interactive learning, drawing, composing, and role playing);
- help learners to become aware of ethical issues relating to the use of computers and to help them develop ethically appropriate attitudes and behaviour with regard to the use of computers;
- help learners to think critically about the computer in order to use it as appropriately and effectively as possible.



GENERAL CONSIDERATIONS

Equity

Education in Ontario should provide all learners with an equal opportunity to develop their potential as far as possible and participate fully in society. The identification and removal of systemic barriers so that everyone has an opportunity to succeed is a prerequisite for achieving equity. To detect entrenched obstacles, educators must examine not only individual opportunities and access but also actual outcomes and results.

In a school environment there may be subtle though unintended barriers, such as the use of computer software that may appeal to only one group or gender. To ensure equity for all learners, the school environment should be modified so that it clearly meets the needs of all individuals. Such modification will require educators to adapt their pedagogical practices to learners' diverse learning styles, abilities, talents, and backgrounds. All learners should see themselves reflected in all aspects of the curriculum. Curriculum resources must be inclusive of the diverse groups in society and free from bias with respect to gender, age, race, ethnicity, belief system, socio-economic status, and exceptionality. Resources should also be varied enough to accommodate the range of student learning styles.

Because computers are adaptable to a wide variety of needs, interests, and abilities, their use in the curriculum can promote equity. This resource is particularly useful in removing barriers to learning for exceptional students. For example, computers can be used to print Braille or to synthesize a human voice that will read to individuals who have a visual impairment, and to facilitate the acquisition of literacy and numeracy skills among learners who lack them.

Access to the use of computers should be provided on an equitable basis for all learners in order to foster equal opportunity for learning.

Ethical Questions

The computer is a powerful tool. It can give the user unprecedented access to many different types of information, including databases and personal files. It can also be used to copy software. As is the case for any instrument with potentially harmful uses, the ethical and legal implications of such practices must be clearly understood. Without proper authorization, it is unethical and illegal to try to gain access to electronic data or to copy materials created and owned by others. It is important for educators both to demonstrate respect for personal privacy and copyrights and to encourage and assist all learners to do so as well.

THE LEARNER

The many and varied applications of the computer make it an extremely useful teaching and learning tool for teachers seeking to meet the needs of students with different learning styles and a wide range of interests and abilities. The integration of the use of computers into the classroom facilitates student-centred learning within an enriched learning environment.

The Individual Characteristics and Needs of Learners

Every learner is unique. Learners have different abilities, interests, and backgrounds. They develop physically, intellectually, and emotionally at different rates. They also have different learning styles: some may favour the visual mode, others the auditory or kinesthetic mode.

The use of computers can help teachers to adapt their teaching and learning strategies to the individual needs of learners. For example, the needs of visual learners can be met through programs that use colourful graphics or animation (e.g., pictures of objects to illustrate an addition problem). For auditory learners, programs are available that use sound to reinforce what is depicted on the screen (e.g., sounds that reflect the moods evoked by words). For kinesthetic learners, opportunities can be provided to construct robots and other computer-controlled devices. Multi-media programs that combine a number of modes of learning can offer a multi-sensory learning environment suitable for a variety of learning styles.

The General Characteristics and Needs of Learners

While it is important that learning opportunities which meet individual and/or special needs be provided, needs common to all learners should also be considered. Computers are especially useful to teachers in this regard, since they meet these common needs on an individual basis. For example, learners generally enjoy, respond to, and benefit from receiving immediate feedback and ongoing encouragement. Computers can offer learners a "safe" environment in which they feel free to take risks and learn from their mistakes.

Computers are also suited to meet many of the basic needs of any learner. Such needs include opportunities for the learner to:
- participate actively in the learning process;
- communicate his or her ideas;
- interact with others in co-operative ways;
- examine his or her own values and those of others;
- acquire information from a variety of sources;
- conduct inquiries;
- analyse information and ideas;
- synthesize information and ideas;
- evaluate and reflect;
- create.

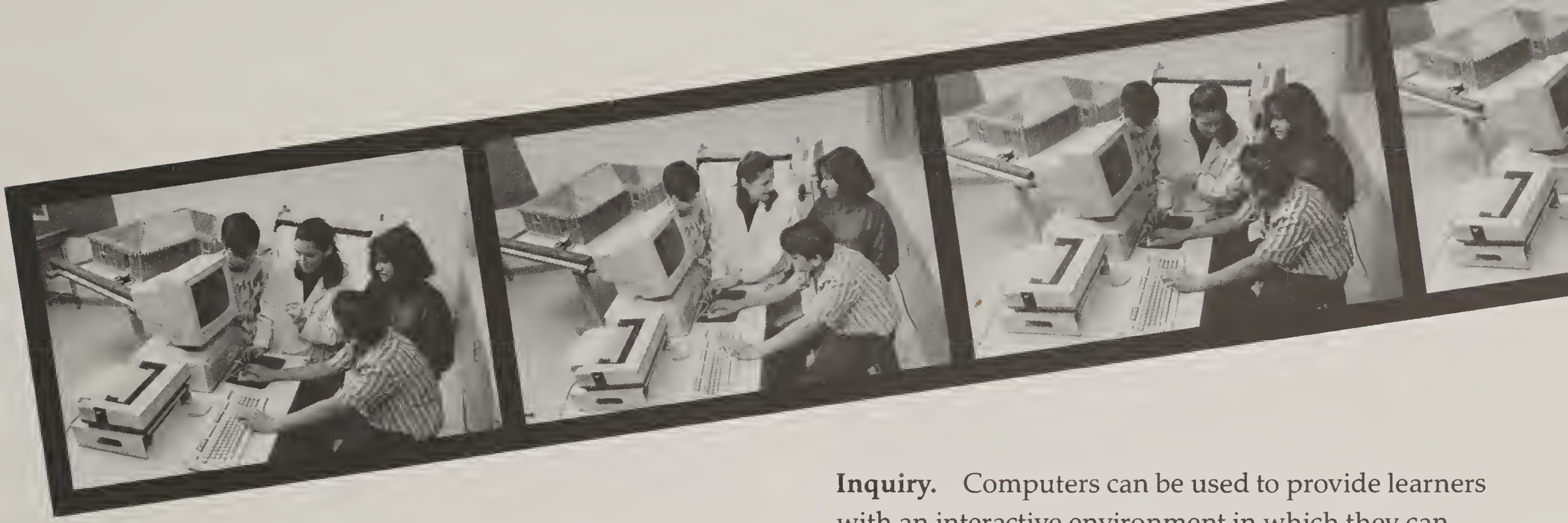
The following examples show that computers can be used to meet learners' needs in a variety of areas.

Active Participation. Computers can be used to provide learners with a variety of stimuli (visual, aural, and kinesthetic) that will focus their attention, encourage them to explore and experiment, and thus promote their active involvement in the learning process. This interactive mode allows the learner to leave the computer to conduct an activity and then return with information to further the interaction. This type of active involvement may occur an indefinite number of times until the investigation is complete.

Communication. Computers can help learners to develop their ability to communicate in a variety of ways. For example, in language classes, learners can use computers to publish and share personal writing. (Word-processing and desktop-publishing programs enable learners to produce work in more professional formats. Research also indicates that many learners who use such programs write more and are more willing to revise their work.) Computers also enable learners to communicate with their peers in other communities throughout the province.

Multi-media programs allow learners to use a variety of methods of presentation (e.g., videodisk, CD-ROM, graphics, text, and sound) to express themselves.

In special education, augmentative devices (e.g., a unicorn board) can be used to enable non-speaking, physically handicapped learners to communicate.



Interaction. The use of computer simulations can encourage learners to interact and co-operate effectively with others. Groups of learners around a single computer can reach a consensus on a decision and then proceed to implement it. Students working at different computers can reach co-operative decisions through telecommunications and networking, and support their hypotheses by accessing online CD-ROMs and other research tools.

Examination of Values. Computer simulations involving a variety of social, cultural, economic, and political contexts, both contemporary and historical, can provide learners with opportunities to examine values that differ from their own. In addition, learners can use telecommunication networks to learn about other cultures and countries.

Research. Computers can greatly expedite the task of gathering and retrieving information, and thus free learners to spend more time on the analysis of data. Videodisks, telecommunication and computer networks, and databases from around the world can be used to gain access to relevant information that may not be readily available through more traditional means. In a science class, probes and sensors can be used to record and present data instantaneously. In an auto mechanics class, computers can be used to diagnose problems that learners then attempt to solve.

Inquiry. Computers can be used to provide learners with an interactive environment in which they can explore problems (both real and imaginary), test hypotheses, and generate solutions. Computer software allows learners to experiment with models that would be difficult to construct using other media.

Analysis. Computers allow learners to focus on the analysis of information in a variety of forms, such as graphs, maps, tables, and charts. "What if?" programs allow learners to extend the boundaries of a problem and experiment with a number of alternatives.

Synthesis. Computers enable learners to combine and recombine ideas and concepts in unique ways. For example, in music, computers can be used to compose a song; play it; illustrate its lyrics; experiment with different tones, instruments, and tempos; edit its various parts; and then record it or print it out.

Evaluation and Reflection. The use of computers in the classroom in conjunction with a range of other types of learning strategies can provide learners with valuable opportunities to compare and evaluate different ways of achieving particular goals. Such opportunities will help learners to develop the ability to judge whether use of the technology is appropriate in a particular case. The process of evaluation may require learners to assess not only the effectiveness of a particular strategy or tool but also its ethical implications.

Creativity. Learners' creativity is stimulated by the many programs that allow them to simulate, explore, and test a variety of models and alternatives. As well, open-ended computer software enhances learners' ability to express themselves creatively in a variety of areas (e.g., writing, drawing, and composing music).

To meet learners' needs in these ways, all schools should provide learners with opportunities to:
- use computers to enhance their learning;
- use a variety of configurations of computers to explore ways of communicating and collaborating with others, both inside and outside the school;
- demonstrate an understanding of the value and limitations of computers in their daily lives and in society.

The Characteristics and Needs of Adult Learners

Adult learners come from diverse backgrounds and have different learning styles. Their interests may be wide-ranging and their attitudes quite varied. As well, they will differ in age, level of formal education, personal time commitment, occupation, and family responsibilities. Many will bring a vast range of practical experience to the learning process.

Where there is such wide variation among learners, computers can provide invaluable assistance in meeting individual learning needs, allowing each learner to build on his or her particular strengths and to participate actively in the learning process.

Adult learners are highly motivated and usually decide to take formal education for a defined purpose. They are willing to undertake studies and training that can help them in pursuing their present careers, in seeking new ones, and in upgrading their education. They are also often eager to explore new programs and tools in order to attain their objectives. Many of them feel that knowing how to use computers will expand their opportunities for employment.

The presence in the classroom of adult learners who hold such views can enhance the learning process for younger students. Adult learners can serve as role models who demonstrate a commitment to lifelong learning and who understand the importance of acquiring the skills they need to live and work in today's and tomorrow's world.

THE LEARNING ENVIRONMENT

The School and Classroom Climate

The climate of the school and classroom should be both reassuring and stimulating to learners. An atmosphere of trust facilitates learning; learners need to feel accepted and respected and to know that their needs and abilities are recognized. The learning opportunities provided should be designed to motivate learners, expand their horizons, promote active participation, encourage communication, and foster self-esteem.

The use of computers can help teachers to provide such an environment by enabling them to adapt activities to the individual needs and abilities of learners and to broaden the range of learning opportunities and resources offered.

Resources and Activities

A good variety of software programs, multi-media equipment, and telecommunications facilities is needed to support a range of stimulating learning activities. Such activities might include opportunities for learners to:

- use an electronic bulletin board to share information with learners in other communities;
- consult a variety of electronic resources for a research project;
- use a CD-ROM to learn English or French as a second language;
- use a computer attached to a videodisk or CD-ROM player to work on a historical simulation with other learners, then co-operate to make decisions and prepare a presentation for the rest of the class;
- use electronic publishing to create, illustrate, and revise a piece of work;
- use computer-mediated communication software to debate an environmental issue with a group of learners in another part of the school.

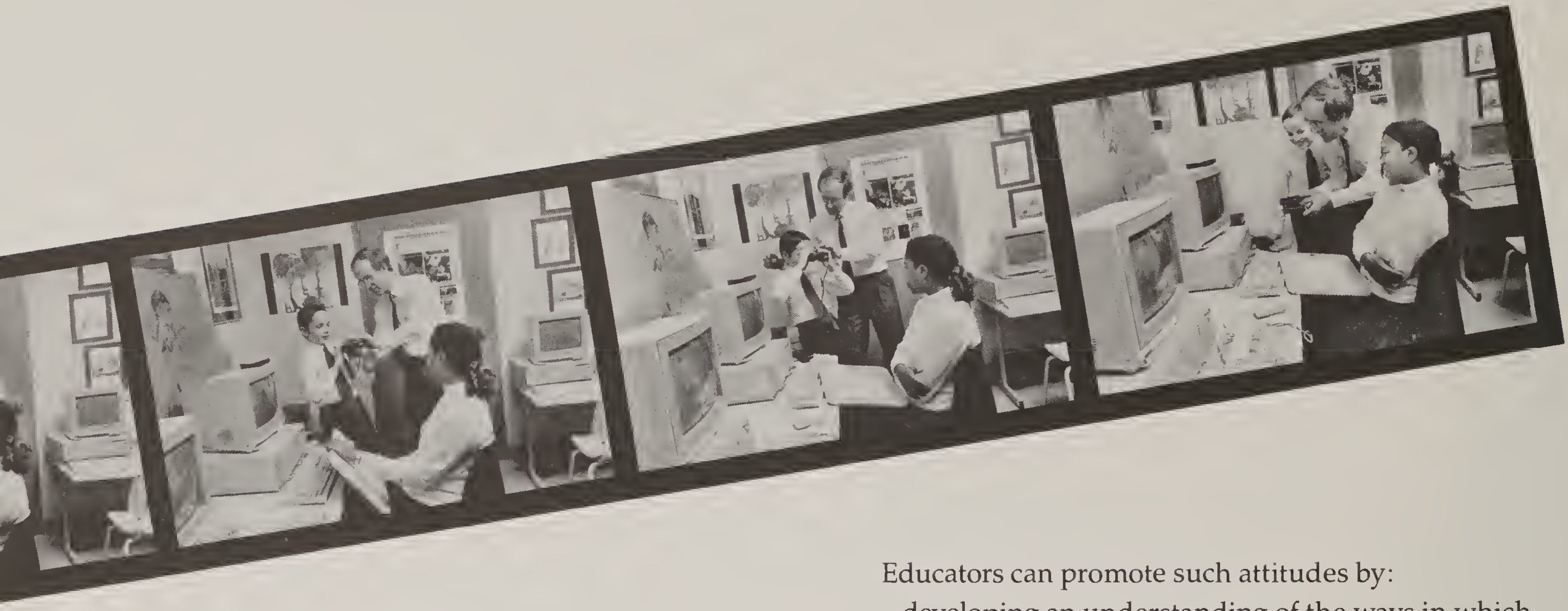
Design Considerations

The teaching/learning strategies selected will, at various times, call for learners to work in groups, individually, or with partners. The location and arrangement of computers in the school and classroom should allow for such variations. Possible arrangements include classroom activity centres with from one to four computers and computer classrooms with many computers. Learners become more actively involved in learning with computers when they have the opportunity to work individually, with partners, and in group-learning situations.

When a computer classroom is used, it is important for the regular classroom teacher to work with the computer teacher in planning activities and/or to accompany the learners to the classroom so that the computer activities can be directly related to regular work.

In designing an appropriate classroom environment, it is important to consider such things as lighting, seating arrangement, work space, ventilation, safety, and ergonomics. More than one learner should be able to work at a single computer without being crowded or physically cramped.

Computers networked throughout the school allow for the sharing of resources and for communication among learners and teachers. When designing such a network, it is important to ensure that the necessary electrical, telephone, and cable supports are available.



The Educator's Role

Educators act both as facilitators, helping students to learn, and as role models, demonstrating appropriate behaviour and attitudes.

Educators have a responsibility to create learning environments that present learners with successful and challenging experiences and foster a positive attitude towards achievement. Such environments are greatly enhanced by the use of computers and appropriate software. Computers, like books and many other learning resources, can help teachers to expand the limits of what can be experienced in the classroom: they can open for learners a world of communities, real and imagined, in which they can explore, experiment, and learn.

As role models, educators can demonstrate positive attitudes to the use of computers that will, in turn, help learners to regard computers as a familiar, comprehensible, non-threatening part of their environment. In doing so, they can motivate learners to seek new and additional ways of using the computer.

Educators can promote such attitudes by:
- developing an understanding of the ways in which computers can enhance learning;
- incorporating the use of computers into their repertoire of teaching tools as a standard feature rather than an optional resource;
- using computers appropriately and effectively;
- providing opportunities for all learners to learn in a variety of learning situations (e.g., individually, in pairs, and in groups);
- ensuring that students have access to a variety of software, multi-media equipment, and telecommunications facilities;
- allowing learners to work with a computer network that gives them the opportunity to share resources and communicate with other learners and teachers;
- providing opportunities for learners to become aware of the versatility of the computer as a working and learning tool (e.g., for review and practice, composition, the organization and presentation of information, and the storage and sorting of data);
- helping learners achieve an understanding of the safe and ethical use of computers.

PLANNING AND IMPLEMENTATION

GENERAL CONSIDERATIONS

The Goals of the Planning Process

Careful planning is required to ensure the successful integration of the use of computers into the curriculum. The overall goals of the planning process are to:
- ensure that computer activities meet the needs of all learners;
- incorporate computer activities into the whole curriculum in such a way that teachers and learners are able to welcome the computer as an effective and useful working and learning tool;
- ensure that all learners at all grade levels and in all subjects have equitable access to the use of computers;
- ensure that the available educational resources are being used as effectively as possible;
- clarify the responsibilities of those involved in the planning and implementation process;
- allow for the preview, selection, and acquisition of new hardware and software, and the disposal of old equipment.

The Scope of the Planning Process

The process of integrating the use of computers into the curriculum requires planning and collaborating at the board, school, and classroom levels. Partners in the process include the ministry, school board officials, principals, teachers, students, and community and business representatives. Plans should include clarification of the responsibilities of each of these groups.

Assistance With Planning

Information is available to assist school boards and teachers to develop:
- guidelines for the use of computers at all levels;
- the appropriate expectations for the application of computers across all curriculum areas;
- specific statements, explanations, and learning expectations regarding the use of computers within the learning process. These statements should outline suggestions for the use of the computer as both a working and a learning tool in both individual and collaborative modes;
- assessment and evaluation methodologies for use with computers;
- appropriate expectations for the use of computers by learners in each program area.

Since 1986, the ministry has funded a variety of school board projects throughout Ontario related to the development of innovative uses of computers and the incorporation of computers into the curriculum. The resulting research studies, videotapes, and reports may be helpful to planners and can be obtained through the ministry's regional offices.

The ministry encourages the co-operative development of models and resources for the use of computers in the curriculum in a variety of ways. For example, it promotes collaboration among the ministry, school boards, faculties of education, and other interested parties for the purpose of developing and sharing materials; and it provides information to

boards, teachers, community members, and special-interest groups wishing to work together to develop and publish resource documents and board- and school-based plans.

Implementation Schedules

The implementation process will vary from board to board, depending on the individual board's current level of integration, on the availability of ministry funding from year to year, and on the board's own budgetary commitments. Although it is unrealistic to expect that complete integration will occur immediately, long-range plans can assist school boards in meeting their goals.

ROLES AND RESPONSIBILITIES

School Boards

The specific responsibilities of school boards, as well as details on the kind of information that boards must include in their implementation plans, are given in section 1 of Policy/Program Memorandum No. 116 (see Appendix 1).

Implementation plans should account for the many ways in which computers can facilitate the delivery of instruction to learners. As well, where necessary and appropriate, plans should give consideration to non-traditional methods of instruction, such as co-operative education, independent study, and distance education.

Principals

Policy on the responsibilities of principals in developing plans at the school level is given in section 2 of Policy/Program Memorandum No. 116 (see Appendix 1).

School boards should encourage principals and teachers to form a team to develop an annual plan that describes the process of integrating computers into the school curriculum. This plan should be communicated both to parents and guardians and to the school board staff.

Principals should also take advantage of opportunities to develop their own computer skills in order to demonstrate appropriate attitudes towards the use of computers.

1. Development of the School Plan

The school plan should be developed by a planning team composed of the principal and staff members representing the various levels and curriculum areas. This team should also include representation from major stakeholder groups in the community, such as students, parents, and business people.

During the planning process a variety of factors should be taken into account, including any special characteristics of the school, the individual needs of the learners, and the expectations of parents and the community. Planners should seek to ensure that effective use will be made of the material and human resources available in the school and in the community.

The school plan should:
- identify curriculum goals and activities related to the use of computers;
- contain an inventory of the school's current hardware and software resources and proposals for allocating those resources;
- identify current and future hardware and software needs;
- address the need for procedures to be followed in evaluating software learning materials to ensure that they are culturally appropriate, factually correct, and free from bias and stereotyping;
- provide for equitable access to the use of computers for all learners in all curriculum areas;
- identify staff members with expertise in the use of computer hardware and software who will be available to assist teachers, principals, and other staff members during the implementation process;
- address the need for professional development activities that will provide teachers with information about appropriate classroom strategies, resources, software applications, and hardware operations;
- address the need for evaluation procedures that will determine whether the implementation goals are being met and that will be used to assess students' progress in learning.

2. Implementation of the School Plan

It is important for all staff members to participate in the implementation process and to feel a sense of responsibility and commitment towards its goals. The principal should provide opportunities on a regular basis for staff members to share their ideas and concerns about the integration of computers into the curriculum.

Principals should:
- help teachers to prepare teaching goals with regard to the use of computers;
- ensure that learners have equitable access to the use of computers;
- help staff members to identify personal goals for acquiring expertise in the use of computers;
- develop an overall professional development strategy for the school staff and enable staff members to take advantage of available professional development opportunities in this area;
- ensure that the arrangement of computer installations in the school is compatible with the curriculum needs identified, the teaching and learning strategies selected, and the physical structure of the school.

Teachers

Teachers should work with other members of the school staff in planning for the integration of computers into the curriculum. When planning lessons they should also ensure that the use of computers is appropriate to the objectives of the lesson and that it is incorporated into the curriculum in a balanced way.

In integrating the use of computers into the learning process, teachers should provide students with opportunities to:
- work individually and co-operatively (either with a partner or with a group of learners);

- use computers for a variety of purposes, including problem solving, communicating, experimenting, information processing, creating, and composing;
- become familiar with a variety of hardware operations and software applications.

Teachers can facilitate the integration of computer technology into their classrooms by:

- defining teaching goals for the use of computers in their classes, developing teaching and learning strategies that will help them achieve these goals, and identifying and organizing resources appropriate to the strategies selected;
- incorporating into their plans strategies for the review of their goals and activities so that they should be able to make revisions as necessary;
- developing a plan for professional development activities that will help them increase their knowledge of the uses of computers in education;
- co-operating with other staff members in planning the integration of computers into the curriculum.

The Teacher-Librarian

The teacher-librarian can make the library the focal point for change and for the acquisition of resources. The librarian should play a major role in facilitating the integration of computers into the curriculum by:

- working with teachers to identify new types of materials and sources of information that should be acquired (such as CD-ROM disks and telecommunications services);
- using electronic tools to access traditional resources (such as atlases, an electronic card catalogue, and encyclopaedias);
- evaluating new materials to ensure that they are culturally appropriate and free from negative bias and stereotyping.

By utilizing such resources, the teacher-librarian can be instrumental in planning and developing units of study, in collaboration with teachers, that integrate the use of computers with other learning resources and strategies.

EVALUATION OF IMPLEMENTATION

The provision for ongoing review included in school board and school implementation plans will enable boards and schools to measure the progress they are making towards integrating the use of computers into the curriculum. Using the established mechanisms for review, boards and schools should work together to determine what progress has been made, to redefine existing objectives, and to identify new ones.

EVALUATION OF PROGRAMS AND LEARNERS

Evaluation helps educators to determine the effectiveness of the strategies used and to identify modifications that are needed to enhance learning. In general, the focus of program evaluation should be on the use of computers in specific curriculum areas and on its effectiveness in achieving the objectives and aims outlined in the curriculum guidelines.

Evaluation also provides educators with information that assists them in developing individualized programs for learners. The evaluation of learners should be both formative and summative. Formative evaluation is ongoing and allows teachers to monitor learners' progress and adjust programs as required. Summative evaluation provides a means of taking stock of learners' achievement at the end of a learning sequence.

Some attention should also be given to assessing learners' computer manipulation skills. Information obtained from such assessment will allow teachers to determine the scope of the computer applications possible and identify and plan for the specific skills that must be taught. The level of each learner's technical competence should not be given undue weight, however. For example, the main objective of a Grade 5 teacher is not to help learners to develop their word-processing skills to a secretarial level, but rather to help them to improve their writing and communication skills through the use of various resources.

STUDENT SELF-EVALUATION

The ability to evaluate one's own productions and performance is an essential skill that individuals will require throughout their lives. One way of developing self-evaluation skills is to make mistakes and learn from them. Computers facilitate such development by enabling learners to engage in this aspect of learning in a non-critical environment.

It is important for teachers to regard the development of learner self-evaluation skills as a major objective and consequently to include it among their criteria for assessing the effectiveness of their use of computers in the curriculum.

CONCLUSION

The use of computers across the curriculum has the potential to contribute significantly to the achievement of Ontario's learners. This is especially true for exceptional students, whose opportunities for an education that will enable them to participate fully in society have been enormously increased by the use of computers.

The knowledge, enthusiasm, and commitment of educators are essential to the implementation process. Through their continuing efforts to use computers to enhance learning, Ontario's educators can help to prepare learners for a world in which learning will be a lifelong process.

APPENDIX 1. POLICY/PROGRAM MEMORANDUM NO. 116

Ministry of Education
Ontario

Issued under the authority
of the Deputy Minister
of Education

Policy/Program
Memorandum
No. 116

Date of Issue: September 18, 1992

Effective: Until revoked or modified

Subject: INTEGRATION OF COMPUTERS ACROSS THE CURRICULUM

Application: Directors of Education
Principals of Schools

Introduction

Policy/Program Memorandum No. 113, May 31, 1991, announced that school boards would be required to submit annual planning and progress reports on the integration of computers into all curriculum areas, beginning in 1992.

The present memorandum provides guidelines for school boards to follow when developing their implementation plans for the integration of computers across the curriculum, as well as information on planning at the school level, on the annual planning and progress reports, and on audits.

1. School Board Implementation Plans

School boards are responsible for developing flexible, long-term plans for the integration of computers into the curriculum. Minority-language sections are expected to develop their own long-term plans reflecting their specific needs. These plans shall be made available to the Ministry of Education upon request.

Each school board shall designate a supervisory officer to ensure the development of the annual plan and to provide schools with appropriate support, as needed, during implementation.

The following information shall be included in the board implementation plan.

a) Curriculum

The plan shall outline strategies for:
- the integration of computers into all areas of the curriculum in all schools;
- the development of learning objectives for the use of computers in all grades and in all areas of the curriculum;

- the sharing of curriculum resources among schools, divisions, departments, and teachers.

b) Equity

The plan shall identify procedures for:
- ensuring equitable access for all students to the use of computers in the classroom;
- evaluating all software to determine whether it is culturally appropriate for all students, factually correct, and free from bias and stereotyping.

c) Professional development

The plan shall address:
- activities designed to help teachers understand the impact of computers on the education process;
- staff development programs to provide educators with information on classroom activities, software applications, hardware operations, and resources.

d) Community partnerships

The plan shall address the need to:
- consult with parents and community members about board and school plans;
- share information with parents and community members about the implementation process;
- work with parents and community members to plan for the use of computers in meeting the needs of all students.

e) Special education

The plan shall:
- identify and allocate computers and resource materials to meet the needs of exceptional students;
- provide a variety of devices, as needed, to assist exceptional students to learn and communicate;
- provide direction for teachers and support staff regarding the uses of computers to meet the special needs of exceptional students.

f) Acquisition of resources and equipment

The plan shall address:
- a review of the board's current inventory of computers and related resources in order to allocate resources efficiently and determine future needs;
- a set of long-range objectives for acquiring sufficient computer hardware to allow every student access to a computer for a minimum of 10 per cent of in-class time;

- the disposal, replacement, and upgrading of outdated equipment;
- the provision of safe and ergonomically suitable environments for the use of computers.

g) Staff support

The plan shall address the need to:
- provide, to the best of the board's ability, both curricular and technical resource staff support to assist teachers, principals, and other staff members in the use of computer hardware and software;
- enable educators to share information and experience within the board and to consult experts outside the board;
- identify teachers who could serve as resource persons during the review, development, and implementation process.

h) Evaluation

The plan shall provide for:
- an ongoing review of the implementation process to ensure progress towards meeting the overall goals of the plan.

2. School Level Planning

Planning at the school level shall reflect and be co-ordinated with provincial and school board plans and policies. Each school should provide the board with a copy of its plan, to assist the board in developing its own overall plan.

Principals are key catalysts for change in schools and are expected to assume an active leadership role in the integration of computers across the curriculum. While they are ultimately responsible for planning and implementation at the school level, they shall carry out these activities in consultation with teachers from all divisions and subject areas, in order to ensure the integration of computers across the entire curriculum.

3. School Board Reports

The School Board Report on Computer Integration, which is being sent to school boards, will form the basis of the annual planning and progress report submitted by each school board.

4. Random Audits

Beginning in the 1993-94 school year, random audits at both the school board and school levels will be undertaken by the Ministry of Education to assess progress in the area of integration of computers across the curriculum.

APPENDIX 2. PLANNING GUIDE

The Ministry of Education and Training encourages school boards to use the following three checklists in planning for the use of computers across the curriculum in both the elementary and the secondary panels.

Computer Hardware

Has the board:
- acquired microcomputers that meet the functional requirements published by the ministry?
- provided appropriate furniture, lighting, space, electrical outlets, and cabling to ensure an ergonomically sound and safe environment?
- provided sufficient numbers of microcomputers to allow every learner access to them?
- purchased the necessary peripherals to permit flexible and wide-ranging use of the new technology in all areas of study?
- set up a variety of computer configurations?
- provided the necessary elements for local and long-distance communication?
- acquired specialized hardware and peripherals in order to ensure equitable access for learners with exceptionalities?

Educational Software

Is the board using computer-based learning materials that:
- allow learners to explore and enjoy enriched learning environments?
- employ the principles of sound learning theories?
- provide opportunities for original thought through open-ended creative experiences and inquiry?
- challenge the intellect through the use of the technology?
- focus on the process of learning as well as on content?
- allow for individual learning styles and abilities?
- span a variety of subject areas and levels?
- provide for the needs of learners with exceptionalities?
- encourage social interaction, collaboration, and peer tutoring?
- can be easily used, even by novices?
- provide networking opportunities for learners?
- are culturally appropriate and free from negative bias and stereotyping?

Staff Support

Has the board:

- appointed personnel, as required, to provide effective curriculum and technical support for teachers, as well as principals and other administrators, in their implementation of the use of computers?
- allocated time for teachers to develop comprehensive implementation strategies?
- provided in-service training for teachers in the curriculum-based use of computers?
- provided release time for this in-service training for teachers, consultants, and principals and other administrators?
- provided for the sharing of curriculum, technical, and in-service resources with other boards?
- designed activities to foster awareness (on the part of teachers, consultants, and principals and other administrators) of research findings applicable to the use of computers?
- shared information about the integration of computers into the learning process with parents and the community at large?

GLOSSARY

CAD (Computer-Aided Design). A graphics program that assists in the design and/or drawing of plans, microcomputer circuitry, and products and their containers. Use of such a program can save time, money, and resources.

CD-ROM (Compact Disk with Read-Only Memory). A compact disk containing a large amount of information (data), for example, an entire encyclopaedia, or talking books featuring stories in various languages, to be read back at a later date. Information cannot be entered and saved on this medium.

Clusters. Small groups of computers located within a classroom.

Computer. A machine that is programmable and capable of processing information. The term is also used to refer to other related technologies and peripherals, such as videodisks, CD-ROMs, modems, and printers, and the appropriate software to make the computer a viable tool within the classroom.

Computer-mediated communication. The use of computers, software, and communication networks to allow individuals to exchange ideas, opinions, and information and to share resources.

Computer network. A series of computers linked together by cables so that they can pass information to each other or share equipment.

Computers across the curriculum. The utilization of computers and associated technologies as an essential learning tool within every division, level, and subject area to facilitate learning and to augment programs offered.

Culture. All the ideas, beliefs, values, activities, and knowledge held in common by a group of individuals who share a common history, geography, religion, race, language, ethnicity, or social tradition.

Curriculum support. Methodologies that facilitate the integration of computer technologies into the curriculum.

Database. An organized collection of data stored in a computer-readable format. It acts as a card-catalogue system for information on a particular area or topic. The data can be manipulated to find commonalities, trends, specific characteristics, etc.

Desktop publishing. A word-processing system that integrates text and graphics to produce newsletters, flyers, yearbooks, etc.

Electronic bulletin board. A system that uses computers, electronic mail, modems, and telephone lines to link computer users from different locations. Messages, requests, questions, responses, and conferences can be shared.

Equitable access. The use of computer and related educational technology based upon needs (e.g., affective, cognitive, physical, linguistic, cultural, and geographical).

Ergonomics. The science of how human beings and machines interact physically, focusing on optimizing safety and productivity.

Peripheral. A device that is connected to the computer and controlled by it. Printers, CD-ROMs, and modems are peripherals.

Telecommunications. A communications network, involving the use of modems and telephone lines, that allows users to contact and interact with one another.

Unicorn board. An adaptive device that can be connected to a computer to provide a means of communication for disabled learners.

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